



Federal Aviation Administration
Office of System Capacity
and Requirements

**Aviation
System
Capacity
Annual Report**

Expand to Meet Demand



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LETTER FROM THE DIRECTOR

We in the Office of System Capacity and Requirements (ASC) are working to identify, develop, and implement initiatives that have the potential to increase the capacity of the national aviation system.

In the Capacity Office, we are well aware of the importance of our job and of the need for the entire aviation community to work together so that we can accommodate current and projected air traffic demand at our airports with a minimum of delay and without compromising safety or environmental considerations.

As we all know, aircraft delays cost the airlines and their passengers many millions of dollars each year. Looking beyond the recent dip in demand for air travel, the current FAA forecasts project that passenger enplanements and aircraft operations will grow at steady rates for the foreseeable future. As the number of aircraft operations increases to meet that demand, delays will also increase, unless improvements are made to aviation system capacity.

Expanding capacity requires an integrated, systematic approach that develops capacity-producing improvements throughout the aviation system. Included in these efforts are airport developments, terminal and en route airspace improvements, enhanced air traffic control procedures, improved weather detection and dissemination, and the application of new technologies. We are developing this integrated approach with emphasis on four major areas: airport capacity, airspace capacity, approach procedures, and weather.

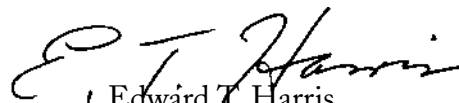
The Capacity Office currently produces several recurring reports.

- The *Aviation System Capacity Plan* is published annually and, in addition to providing airport delay statistics, serves to identify programs that have potential for increasing capacity and reducing delay.

- *Airport Capacity Enhancement Plans* report the results and recommendations of Airport Capacity Design Team studies at individual airports. Over 25 of these plans have been published.
- *Capacity Initiatives* pamphlets describe improvements in air traffic control procedures that have recently become available or will be available in the next three to five years.

All of these reports, however, tend to concentrate on the future and describe potential capacity-producing initiatives. Until now, we have not developed a publication that reports on our accomplishments. That is the purpose of this new report. We are calling it an *Annual Report* because, like the annual reports in the corporate world, it highlights our recent accomplishments and provides some insight into our plans for the future. After a brief introduction, the report will discuss airport development, airspace development, development of new instrument approach procedures, and developments in aviation weather.

We seek innovative solutions to delay problems, and we want to work as closely as possible within the FAA and with the aviation community to attain our stated goal: *expand* the capacity of the aviation system so that it is ready *to meet* projected increases in *demand*.



Edward T. Harris
Director, Office of System
Capacity and Requirements
October 1993

INTRODUCTION

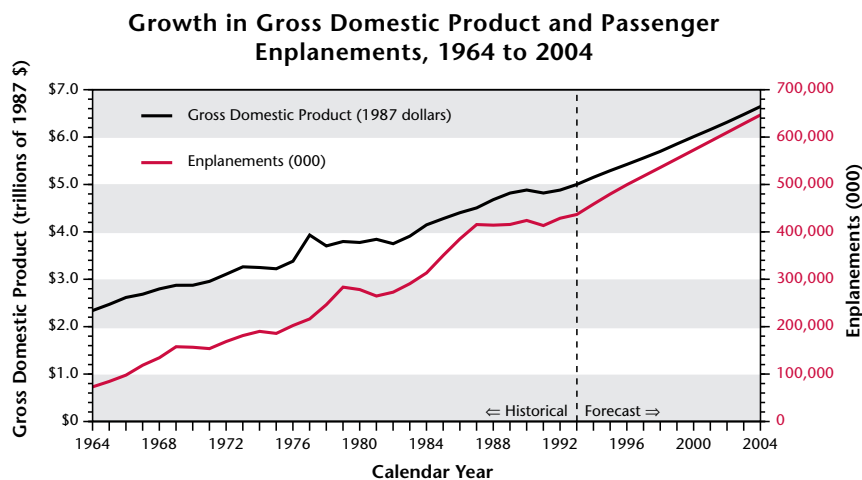
Over the long term, the demand for commercial aviation service has been growing steadily, and this steady growth is expected to continue in spite of the recent dip in the demand for air travel.

Growth in demand, as measured by passenger enplanements, is related to growth in the gross domestic product (GDP, the value of all goods and services produced). Forecasts indicate that both GDP and passenger enplanements will continue to grow at steady rates for the foreseeable future.¹

As demand continues to grow, the burden placed on the national aviation system increases accordingly.



Night operations at Raleigh-Durham International Airport.



Forecasts indicate that passenger enplanements will continue to grow for the foreseeable future.

Until the early 1980's, the infrastructure of our national aviation system, including its airports and air traffic control system, kept abreast of demand. By the mid 80's, however, airports were having increasing difficulty keeping pace with the sharply accelerating traffic growth, particularly those serving major metropolitan areas on the east and west coasts. At our busiest airports, serious congestion problems have become commonplace.

CAPACITY AND DELAYS

The aviation system capacity problem is most often described in terms of aircraft flight delays. When the capacity of an airport or the en route airspace is reached or exceeded, flight delays are the result.

Capacity and delay are generally determined by one or more conditions, including weather, mix and volume of aircraft traffic, capacity of current runway configurations, and limitations or rare outages in airfield and air traffic control equipment. Weather is the most significant of these factors.



A few minutes of delay at the beginning and end of each flight add up to billions of dollars in annual delay costs.

THE COST OF DELAYS

One problem with delay as a measure of capacity is perceptions. Mention an average delay of 10 minutes per operation to typical airline passengers at an airport, and they would probably consider themselves lucky to have arrived or departed so close to their scheduled times. Mention this same delay to aviation professionals, and they would immediately recognize an airport with a capacity problem.




In fact, a few minutes of airport delay at the beginning and end of every flight add up to *billions* of dollars of increased costs to the airline industry, the flying public, and the Federal government.

At a typical large hub airport like Seattle-Tacoma International, which has about 350,000 operations per year, an average delay of 10 minutes per operation would mean more than 58,000 hours of delay per year. At an estimated \$1,600 per hour in aircraft direct operating costs², an average delay of this size would cost the airlines over \$93 million per year at this airport alone.

In 1991, 23 of the country's largest airports each experienced more than 20,000 hours of annual aircraft flight delays. By 2002, we expect such serious delays at 10 more of our airports if no improvements in capacity are made. With an average aircraft direct operating cost of \$1,600, each of these airports could incur a minimum of \$32 million of delay, for a total cost to the airlines of at least \$1.1 billion in 2001.

Aircraft Direct Operating Costs

(1987 dollars)

	Class 1	Single-engine prop under 12,500 lbs.
		\$42 per hour
	Class 2	Twin-engine prop under 12,500 lbs.
		\$124 per hour
	Class 3	Large aircraft under 300,000 lbs. and small jet aircraft
		\$1,607 per hour
	Class 4	Heavy aircraft over 300,000 lbs.
		\$4,575 per hour

AIRPORT DEVELOPMENT

Constructing new airports or new taxiways, ramps, runways, and runway extensions at existing airports are the obvious and most direct actions that can be taken to improve capacity. New airports take many years to evolve from planning through development to actual operations.

The challenge for the aviation community is to maximize existing airport facilities to meet near-term demand while at the same time developing the new facilities needed to meet future demand.

Environmental, financial, and other factors have restricted the development of new airports. Denver International Airport (DIA) is the only major new air carrier airport now under construction. An increased emphasis has been placed on the redevelopment and expansion of existing airport facilities. However, site restrictions, airspace considerations, or concerns about environmental issues often make expansion of existing airports difficult if not impossible. Constructing new airports, implementing joint civilian and military use of military airfields, converting closed military facilities to civilian use, and developing regional airport systems are all possible alternatives. A number of planning studies are underway in major metropolitan areas where additional airport capacity is



New airfield construction projects are the most direct actions to improve capacity.

needed, such as Boston, Chicago, Seattle, and San Diego.

AIRPORT CAPACITY DESIGN TEAMS

The Capacity Office works closely with Airports at the FAA and with the Airports Divisions at the FAA's Regional Headquarters. Since 1985, the FAA has sponsored a program of Airport Capacity Design Teams at major airports throughout the U.S. These teams are composed of FAA personnel, airport operators, air carriers, other airport users, and aviation industry representatives. Each Capacity Team makes use of local and national expertise to identify and evaluate alternatives to enhance existing

airport and airspace capacity. The recommendations developed by the Capacity Teams deal with airfield, facilities and equipment, and operational improvements. Alternatives are examined with the assistance of computer simulations provided by the FAA Technical Center in Atlantic City, NJ.



Denver International Airport (DIA) — 10 years in the making

Since the start of the program, over 35 Airport Capacity Design Teams have either completed their studies or have work in progress.

A typical Capacity Team makes 20 or more recommendations for capacity improvements at a specific airport. To date, the Airport Capacity Design Teams have made over 500 capacity-producing recommendations. The biggest capacity gains result from the synergistic effect of combining recommended improvements to the airfield with recommended improvements for new facilities and equipment and improved approach procedures.

For example, Capacity Design Teams can recommend:

- Additional parallel runways to ease arrival and departure congestion. A second independent parallel runway can provide as much as a 100 percent gain in capacity. Over



Airport Capacity Design Teams in the U.S.

20 projects have been recommended to add second, third, and fourth parallel runways.

- New taxiways to expedite the flow of ground traffic and ease congestion. Capacity Teams have recommended new taxiway construction at 16 airports.
- Runway and taxiway extensions, holding areas/pads, and improved runway exits to decrease runway occupancy times and increase runway availability. Nearly 70 of these projects have been recommended at the airports studied to date.
- Improvements in precision landing system equipment to reduce visibility minimums and help to maintain capacity as the weather deteriorates. Over 34 of these projects have been recommended by the Capacity Teams.
- Implementation of improved air traffic control (ATC) procedures designed to provide additional arrival and departure capacity. Capacity Teams have made over 50 recommendations for a variety of ATC improvements.



Airport Capacity Design Teams are composed of FAA personnel, airport operators, air carriers, other airport users, and aviation industry representatives.

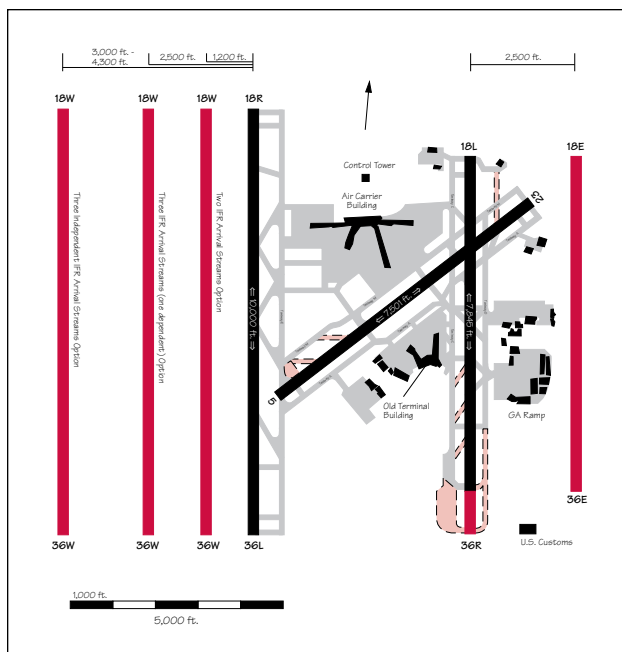
Improvements recommended by the Capacity Teams become part of the master planning process at the airports and will be implemented when needed to meet demand. Many of the airports studied have already begun or completed construction of recommended improvements.

CAPACITY ENHANCEMENT PROJECTS UNDER CONSTRUCTION OR COMPLETED

The following are examples of projects recommended by Capacity Teams that are now under construction or have been completed and should provide significant savings in delay costs.

Charlotte/Douglas International Airport

An extension of Runway 36R is under construction. The extension will permit the concurrent use of Runway 5 for departures while traffic is arriving on Runway 36. Planned angled taxiways on Runway 18L will reduce runway occupancy time to increase arrivals and speed up surface flow. The installation of ASDE would also enhance safety and facilitate better manage-



Charlotte/Douglas International Airport.

ment of surface flow to reduce congestion in poor weather.

The extension of Runway 36R is expected to save nearly 3,300 hours and \$4.6 million in annual delay costs³ when the airport reaches 520,000 aircraft operations per year. At 600,000 annual aircraft operations, the new taxiway is expected to save 9,200 hours and \$12.9 million each year.

Atlanta-Hartsfield International Airport

A new taxiway is now under construction parallel to an existing taxiway, which is currently the only route between the north and south runway complexes. The additional taxiway will reduce congestion by allowing simultaneous two-way traffic and, with the installation of Airport Surface Detection Equipment (ASDE), will enhance safety and improve ground operations during poor visibility.

Chicago Midway Airport

Midway's unique location within an urban metropolitan area where space is at a premium severely limits its physical expansion. The Design Team was challenged to develop initiatives that would work within the current confines of the airfield. The conversion of Taxiway R into Runway 13L/31R for general aviation aircraft allows for the segregation of slower traffic from air carrier traffic and accelerates arrival and departure streams. The rehabilitation of Runway 13C/31C coupled with the extension of Runway 22L has produced results similar to building a new runway. Ground and air traffic flows have been increased and are near maximum.

Detroit Metropolitan Wayne County Airport

An independent crosswind runway recommended in Detroit's 1988 Capacity Team study is under construction and should be completed by late 1993. Recommendations from that study

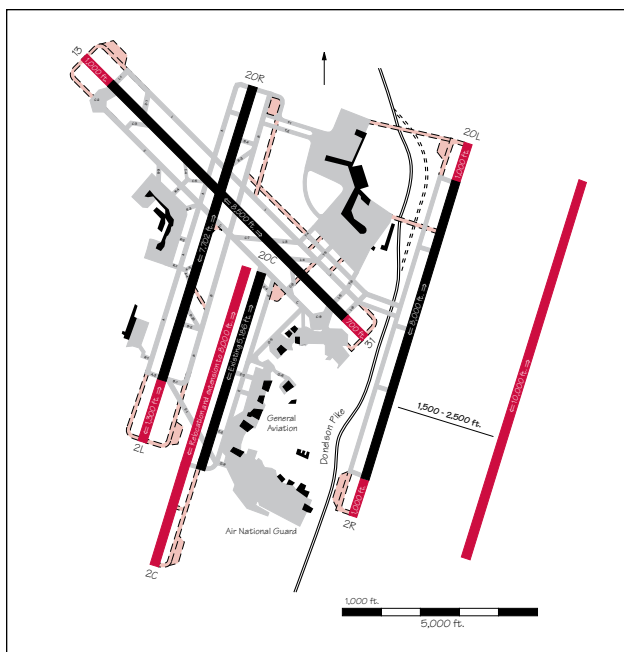
provided a series of runway, taxiway, and holding-apron improvements for a substantial increase in surface traffic efficiency that allowed for a successful expansion of the main terminal.

The new crosswind runway is expected to save 54,990 hours and \$85.3 million in annual delay costs⁴ when the airport reaches 409,000 aircraft operations per year. At 500,000 annual operations, the new runway is expected to save 104,930 hours and \$173.1 million each year.

In the continuing effort to meet ever-changing capacity needs, Detroit is being considered as the first in a series of Capacity Team follow-up studies at selected airports.

Nashville International Airport

The extension and relocation of Runway 2C is currently under construction. The runway will be moved 400 feet to the west, and its length will be extended to 8,000 feet. This will increase flexibility for arrival and departure operations in conjunction with Runway 2L. It will also allow for a separate apron-edge taxiway for general aviation aircraft (GA) adjacent to the GA ramp.



Nashville International Airport.

The new Runway 2C is expected to save nearly 3,000 hours and \$2.9 million in annual delay costs⁶ when the airport reaches 417,500 aircraft operations per year. At 534,000 annual aircraft operations, the new runway is expected to save 7,600 hours and \$7.6 million each year.

Phoenix Sky Harbor International Airport

The completion of a new crossover taxiway between the two parallel runways has expedited the flow of ground traffic to and from the terminals and the north and south runway complexes. In addition, a series of taxiway and exit improvements, which included run-up/hold pads, a holding area, widened fillets, and angled exits, has reduced congestion and runway occupancy times and improved the efficiency of traffic flow throughout the airport.

The new crossover taxiway is expected to save about 3,400 hours and \$3.7 million in annual delay costs⁵ at 465,000 aircraft operations per year. At 550,000 operations, the new taxiway is expected to save 11,000 hours and \$11.9 million each year.

Orlando International Airport

A series of taxiway improvements have provided a bypass capability and improved the flow of ground traffic between the east and west sides of the airfield. In addition, a fourth parallel runway is currently under construction.

The new runway is expected to save \$1.4 million in annual delay costs⁷ at 400,000 aircraft operations per year. When the airport reaches 600,000 annual aircraft operations, the new runway is expected to save \$47.3 million each year. Procedures for triple parallel approaches were published in May 1993. The use of three simultaneous (independent) arrival streams is expected to save an additional \$10.8 million at 400,000 operations per year and \$74.0 million at 600,000 operations per year.

AIRSPACE DEVELOPMENT

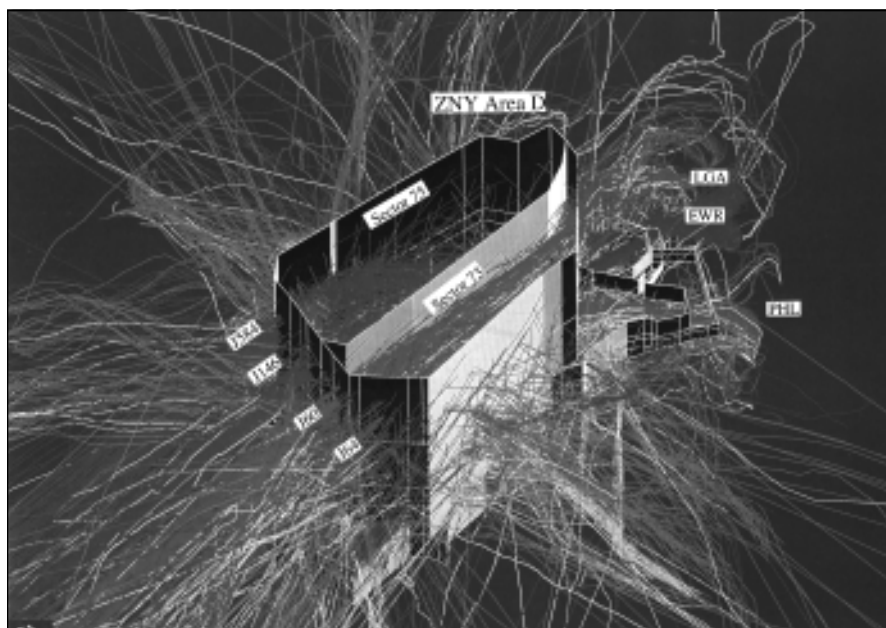
Our efforts to improve airport capacity will not be completely effective unless the terminal and en route airspace can handle the increased traffic. Since 1986, we in the Office of System Capacity and Requirements have been applying the FAA's Airport and Airspace Simulation Model (SIMMOD) to large-scale airspace redesign issues. This airspace capacity design program is intended to identify and evaluate opera-

tional alternatives that have the potential to improve efficiency, increase capacity, reduce delay, and maintain or improve the current level of safety.

Airspace capacity studies have been completed or are underway at 20 major areas in the U.S. The following are examples of completed studies and of the airspace modifications that have been evaluated in these studies.

NEW YORK AIRSPACE CAPACITY PROJECT

The recently completed New York study is the most ambitious airspace analysis project undertaken to date. It analyzed air traffic operations within the New York Air Route Traffic Control Center (ARTCC) and portions of the Boston, Cleveland, and Washington Centers and included data from 18 approach controls and 86 en route sectors. The study focused on proposed airspace restructuring and sector altitude modifications aimed at relieving the complexity and saturation of air traffic operations. It also examined new south arrival and departure routing for Stewart International Airport to support potential future traffic growth and determine the effects on traffic loading. SIMMOD was used to evaluate proposed operational alternatives, such as establishing a new air traffic controller position, rerouting flights to new sectors based on destination or aircraft



Northeast oblique view of radar flight tracks traversing New York Center's Area D in a single day.

type, and changing sector boundaries and altitudes. The results from SIMMOD provide data on traffic loading, controller workload, and delay time. As an example, the resectorization of New York Center Area D could potentially save \$7.6 million in delay costs each year at the current levels of demand and as much as \$71.2 million per year at the demand levels forecast for the year 2003.[†]

OTHER EXAMPLES OF COMPLETED STUDIES

Kansas City Airspace Capacity Project

This study analyzed airspace improvements proposed for the Kansas City ARTCC. The analysis evaluated capacity and delay effects associated with relocating arrival fixes based on a four-cornerpost operation, implementing dual arrival routes, and developing new departure routes for the St. Louis Terminal Radar Approach Control (TRACON). The annual delay cost savings[†] for these airspace realignments would be \$7 million at the baseline level of operations and \$68 million when the level of operations increases by 22 percent. The study also evaluated airport and airspace improvements proposed for the Kansas City TRACON to increase capacity at Kansas City International Airport. A third part of the study analyzed modifications to align Kansas City ARTCC traffic flows with the arrival and departure changes made in the St. Louis and Kansas City TRACONS.

Houston/Austin Airspace Project

The purpose of this study was to evaluate quantitatively the effect of proposed operational alternatives in the Houston and Fort Worth ARTCCs, terminal airspace operations in the Austin TRACON, and airfield operations at the existing Robert Mueller Airport and at the proposed new Manor Airport⁸ in Austin. Delay-cost savings were estimated for these changes under two assumptions, that Austin would become a hub airport and that it would not. At the traffic levels forecast for the year 2000, the proposed airspace realignments would save \$19 million per year for non-hub operations and \$71 million per year for hub operations.[†]

Oakland Airspace Project

The Oakland project evaluated the capacity and delay impacts of proposed operational alternatives within the Oakland ARTCC, the Bay and Sacramento TRACONS, and the San Francisco, Oakland, San Jose, and Sacramento airports. The study included an evaluation of air traffic operations under a proposed Northern California Metroplex Control Facility, which would consolidate operations in the Bay, Sacramento, Stockton, and Travis approach controls. The annual delay cost savings with this redesign and consolidation of airspace, along with a proposed runway extension at San Jose, would be \$45.9 million at the demand levels forecast for the year 2000.[†]

Dallas-Fort Worth Metroplex Project

This project focused on an evaluation of a new airspace design for the Dallas-Ft. Worth Metroplex, an assessment of alternatives for providing and utilizing new runway capacity at Dallas-Ft. Worth International Airport, and an evaluation of the capacity and delay impacts of airspace interactions among



Continental U.S. Air Route Traffic Control Centers (ARTCCs).

traffic from various airports in the Metroplex area. The annual delay cost savings with the redesign of the airspace would be \$32 million at the demand levels forecast for the year 2000.[†]

Los Angeles Airspace Project

This study concentrated on a capacity analysis of Los Angeles International Airport, a delay analysis of airspace choke-points in the Los Angeles ARTCC, and an analysis of an airspace realignment in the Los Angeles Basin. With the redesign of airspace, the delay cost savings would be \$23 million per year with a nominal growth in demand level forecast for the year 2000.[†]

Jacksonville Airspace Capacity Project

This study analyzed air traffic operations in the Jacksonville ARTCC under proposed airspace and route modifications, adjusted sector altitude limits, and a variety of projected traffic levels. The impact of a proposed expansion of a military operating area would result in an annual cost penalty of \$121 million at the demand levels forecast for 2003.[†] The ability to use dual arrival and segregated departure routes under the proposed Orlando TRACON realignment would result in an annual delay savings of \$13 million at the same demand levels.

THE NEED FOR AN INTEGRATED APPROACH

The airspace design projects completed to date have identified tens of millions of dollars in delay savings, and the vast majority of the airspace modifications evaluated in these studies either have been or are being implemented.

The airspace capacity design effort has also served to emphasize the “system” nature of the delay problem and the need for an integrated approach that coordinates the development of capacity-producing alternatives. Airfield improvements, enhanced air traffic control procedures, and improvements in terminal and en route airspace are frequently interrelated — changes in one require changes in the others before all of the potential capacity benefits are realized.

DEVELOPMENT OF NEW INSTRUMENT APPROACH PROCEDURES

Over half of all delays are caused by adverse weather conditions. These delays are largely the result of instrument approach procedures that are much more restrictive than the visual procedures in effect during better weather conditions. The FAA continues to install new instrument landing systems (ILSs) and upgrade existing systems to support continued operations during reduced visibility. In the past few years, the FAA has developed new, capacity-enhancing instrument approach procedures for use under instrument meteorological conditions (IMC) to take advantage of improving technology while maintaining or improving the current level of safety. The goal is to have capacity during IMC equal capacity during visual meteorological conditions (VMC).

Publication of these procedures and development of new procedures is the result of a cooperative effort among Air Traffic, Flight Standards, Research and Development, Aviation Standards, and the Capacity Office.

RECENT NATIONAL STANDARDS

Several new national standards have been published that incorporate some of these capacity-enhancing approach procedures.

- **Simultaneous (independent) parallel approaches using the Precision Runway Monitor (PRM)** to runways separated by 3,400 to 4,300 feet. The average capacity gain expected from this improvement is 12 to 17 arrivals per hour. PRMs are currently scheduled for installation at Raleigh-Durham, Minneapolis, Memphis, Atlanta, and Baltimore.

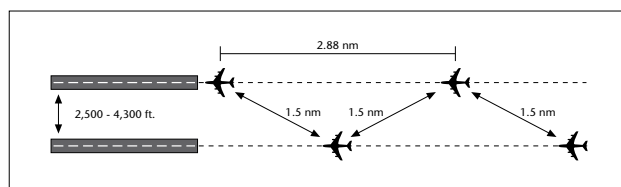
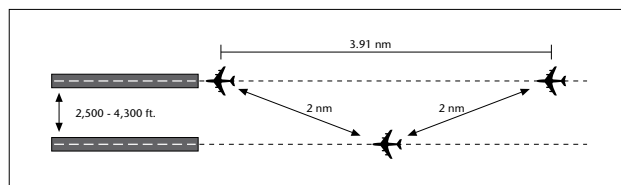
National standard published November 1991. The first PRM was commissioned at Raleigh-Durham on June 30, 1993.



The PRM provides more frequent updates of aircraft positions.

- **Improved dependent parallel approaches to runways separated by 2,500 to 4,300 feet** that reduce the required diagonal separation from 2.0 to 1.5 nautical miles. The average capacity gain expected from this improvement is 4 arrivals per hour. Of the busiest 100 airports in the country, 22 may benefit from this improved procedure.

National standard published June 1992.



Improved separation for dependent parallel ILS operations.

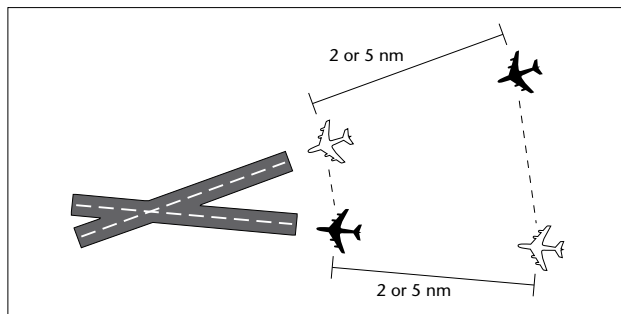
- **Reduced longitudinal separation on wet runways** from 3 to 2.5 nautical miles inside the final approach fix (FAF). The average

capacity gain expected from this improvement is 3 to 5 arrivals per hour. Of the busiest 100 airports in the country, 22 may benefit from this improved procedure.

National standard published June 1992.

- **Dependent Converging Instrument Approaches (DCIA) using the Converging Runway Display Aid (CRDA).** The CRDA update to the ARTS IIIa software projects an electronic “ghost” image of aircraft on converging arrival paths so that separation between aircraft can be verified by the controller during arrival spacing. The average capacity gain expected from this improvement is 10 arrivals per hour. Of the busiest 100 airports in the country, 40 may benefit from this improved procedure.

National standard published November 1992.



Dependent converging IFR approaches using CRDA (ghosting).

- **Triple independent parallel approaches using current radar systems** (4.8 second update rates) to runways separated by as little as 5,000 feet at airports whose field elevation is less than 1,000 feet. The use of triple approaches under IFR could result in a 50 percent increase in arrival capacity compared to dual independent approaches. Of the busiest 100 airports in the country, 6 may benefit from this improved procedure.

National standard published May 1993.

IMPROVED APPROACH PROCEDURES UNDER DEVELOPMENT

New approach procedures continue to be developed to enhance operations and improve system performance. These new procedures are designed to provide additional capacity at existing airports, while maintaining or improving the current level of safety in aircraft operations. The testing of these initiatives is thorough and involves various validation methods, including real-time simulations and live demonstrations at selected airports.

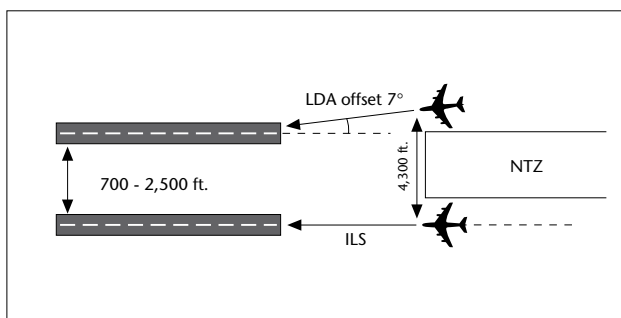
- **Flight Management System (FMS) transition to existing approaches.** Use of FMS computers to transition aircraft from the en route phase of flight to existing charted visual flight procedures (CVFP) and ILS approaches has been demonstrated at San Francisco International Airport and is now in regular use there. FMS-assisted flight path navigation procedures are expected to allow a reduction in weather minimums and offer alternative arrival paths for FMS-equipped aircraft.



The FAA is developing capacity enhancing instrument approach procedures to take advantage of improving technology.

- **Simultaneous operations on wet intersecting runways.** Demonstrations have been underway at Boston, Pittsburgh, O'Hare, Kennedy, Philadelphia, and Miami. At Chicago's O'Hare International Airport, increases of up to 25 percent have been experienced during wet runway operations. Of the busiest 100 airports in the country, a total of 60 conduct hold-short operations and may benefit from this improved procedure.

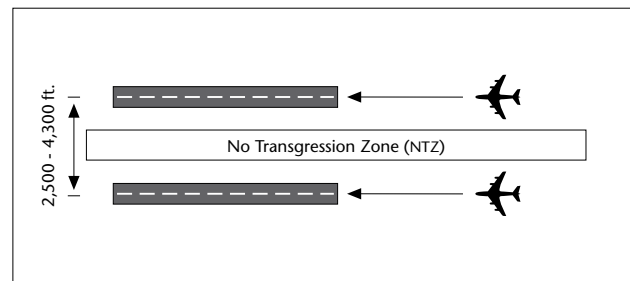
- **Simultaneous ILS and LDA approaches.** Use of an LDA approach in conjunction with an ILS approach on adjacent, closely spaced (700 to 2,500 feet) parallel runways allows an additional arrival stream in weather minimums lower than those required for visual approaches. This procedure has been in use for several years at St. Louis Lambert Field and more recently at San Francisco International Airport. St. Louis has experienced a capacity gain of about 18 arrivals per hour. Of the busiest 100 airports in the country, 30 may benefit from this improved procedure.



Simultaneous ILS and LDA approaches.

- **Simultaneous (independent) parallel approaches using the Precision Runway Monitor (PRM)** (1 to 2.4 second update rates) to runways separated by 2,500 to 4,300 feet. National standards have been published for

independent parallel approaches using PRM to runways that have centerline separated by 3,400 to 4,300 feet. Simulations for parallel runways separated by less than 3,400 feet are being conducted at the FAA Technical Center to determine the minimum centerline distance for independent approaches. Of the busiest 100 airports in the country (based on passenger enplanements), 22 may benefit from this improved procedure.

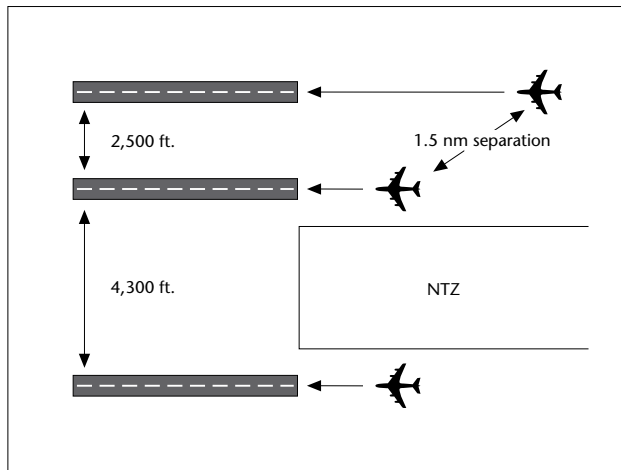


Simultaneous parallel instrument approaches using PRM.

- **Improved operations on parallel runways separated by less than 2,500 feet.** Current air traffic control procedures consider parallel runways separated by less than 2,500 feet as a single runway under IFR. The FAA's wake vortex program is investigating ways to support a reduction in the 2,500 foot requirement under most meteorological conditions. Reducing the separation required by wake vortex considerations would improve capacity for both arrivals and departures. Of the busiest 100 airports in the country, 47 may benefit from this improved procedure.

- **Independent and dependent approaches to three parallel runways.** Airports with spacings from 2,500 to 3,400 feet between one set of runways and 4,300 feet or more between the other set are limited to dual

runway operations. These new procedures would allow triple operations, with dependent operations between the closest set of parallel runways and independent operations between the other set. Real-time simulations of this concept will be scheduled in the future. Of the busiest 100 airports in the country, 10 may benefit from this improved procedure.



Independent and dependent parallel approaches.

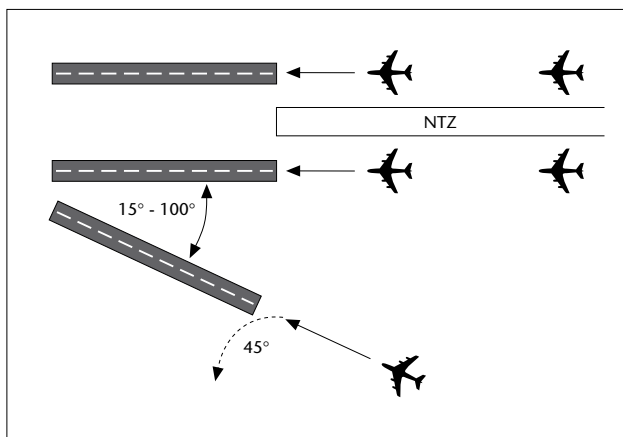
- **Traffic Alert and Collision Avoidance System (TCAS) Cockpit Display of Traffic Information (CDTI) for separation assistance.** The cockpit display of traffic information associated with TCAS can provide the means for flight crews to assist controllers in providing separation assistance and reducing the spacing tolerances that are maintained between aircraft for many phases of flight. A feasibility study for this new procedure was published in April 1991. Data gathering is now underway, and preliminary concept simulations are being devised to test these new procedures in an integrated laboratory environment.

- **Independent parallel approaches to runways separated by as little as 4,000 feet using the Final Monitor Aid (FMA) and radars with 4.8 second update rates that provide at least 2 milliradian accuracy (such as the MODE S or monopulse radar system).** Real-time simulations of this new procedure are underway. Of the busiest 100 airports in the country, 12 may benefit from this improved procedure.



The improved high-resolution display and computer-generated controller alerts of the Final Monitor Aid (FMA) assist the controller in maintaining separation during final approach.

- **Simultaneous (independent) converging instrument approaches.** Improvements in converging runway approaches must take into account the wide variety of converging runway configurations that are in use. This program will investigate potential changes in Terminal Instrument Procedures (TERPS) and air traffic requirements in an effort to improve efficiency of converging approach procedures. As a preliminary step, a work group has been formed to study the various applications available for this new procedure. Of the busiest 100 airports in the country, 38 may benefit from this improved procedure.



Triple approaches — dual parallels and one converging.

Much of the delay in the aviation system could be reduced if the approach procedures used during IMC were able to approximate the operational capacity of those used during VMC. The initiatives in instrument approach procedures we have described focus on the following objectives:

- The use of closely spaced parallel runways for simultaneous or near-simultaneous arrivals.
- More efficient spacing along the final approach path.
- Increased arrival rates to converging and intersecting runways.
- A reduction in the airspace needed to transition to and execute an approach.



New approach procedures are thoroughly tested, often including real-time simulations at the FAA's Technical Center.

DEVELOPMENTS IN AVIATION WEATHER

IMPACT ON SYSTEM CAPACITY

In 1992, about 65 percent of all significant delays were attributed to weather. When weather conditions reduce visibility to instrument flight rules (IFR) operations, separations between aircraft must be increased, and arrival rates and airport capacity decrease accordingly. Instrument approach procedures are much more restrictive than the visual procedures in effect during better weather conditions.

Over half of all delays are attributable to weather.



Improving our ability to forecast the weather offers the potential for increasing system capacity more cost effectively than many other alternatives. Simply knowing when instrument meteorological conditions (IMC) will start and end would result in significant improvements in capacity. Many of the delays due to weather result from not being able to predict this information accurately. For example, because of morning fog at Chicago O'Hare, air traffic control (ATC) may have limited the arrival acceptance rate to 50 percent of potential and begun a ground hold that is expected to continue until 11:00 a.m., based on a forecast that the fog will not lift until that time. If the fog actually lifts at 10:00 a.m., the pipeline of aircraft will not be filled quickly enough to

regain normal acceptance rates until at least 11:00 a.m., even if the ground hold is removed immediately. Thus, inadequate weather information results in an unnecessary loss of 50 percent of capacity at Chicago O'Hare for the hour between 10:00 a.m. and 11:00 a.m., and this loss of capacity has a ripple effect throughout the national aviation system.

Improved weather information enhances flight safety, improves flight planning and efficiency, reduces ATC and pilot workload, and increases system capacity. Improved flight planning saves fuel and reduces costs.

Efforts are underway to enhance our understanding of and our ability to observe and predict a wide range of aviation weather phenomena for both domestic and oceanic airspace.

- Aircraft icing, surface and aloft.
- En route and transition turbulence.
- Ceiling and visibility.
- Thunderstorms and microbursts.
- En route and terminal winds and temperatures.

To better observe current weather and generate more accurate short-term forecasts, various models, algorithms, and meteorological sensors are being developed. Surface-based and airborne sensors, as well as weather radars, are now being implemented to provide near-real-time three-dimensional weather data that is not now available.

ACCOMPLISHMENTS

Winds and Temperatures Aloft

Knowledge of current and future winds and temperatures aloft is critical to FAA traffic management functions and to airline flight planning to determine optimum routing, time en route, and fuel management. To improve the quality and timeliness of this information, the FAA has acquired access to automated reporting of near-real-time observations of winds and temperatures aloft from aircraft equipped with the ARINC Communication Addressing and Reporting System (ACARS). These observations are then transmitted to the National Weather Service (NWS), which in turn produces a data base and a series of products describing current and future wind and temperature conditions aloft. This program is called the Meteorological Data Collection and Reporting System (MDCRS). MDCRS is currently collecting 8,000 automated reports per day. In FY94, the rate is expected to increase to 16,000 reports per day. MDCRS has already produced a 25 percent improvement in the accuracy of forecasts of winds and temperatures aloft.

International Aviation Weather Codes

The Capacity Office led the interagency effort (FAA, NWS, DOD, and DOS) to establish a U.S. position on standards proposed by ICAO for surface weather observations (METAR) and for terminal weather forecasts (TAF). The Office then led the effort within FAA to develop an implementation plan. The first phase was completed on July 1, 1993, with the transmission of METAR and TAF weather information from 250 and 80 airports respectively. Adopting a common international aviation weather code for pilots and flight operations personnel worldwide will reduce the cost of avionics by providing weather information in common units and formats, reduce training time, and reduce the chances for any errors by misinterpreting weather information due to code differences.

National Aviation Weather Program Plan Published

Providing aviation weather services to the aviation industry is a joint effort of the FAA and the NWS, with support from DOD. In response to industry interest, a National Aviation Weather Program Plan (NAWPP) was completed and published last November. The Capacity Office led the interagency planning effort, under the auspices of the Office of the Federal Coordinator for Meteorology. Other federal agencies participating in the study were NWS, DOD, NASA, and National Transportation Safety Board (NTSB). The focus of the NAWPP was on identifying the high-level needs of industry users for aviation weather services and assigning priorities for fulfilling those needs. This planning effort employed extensive industry user involvement and produced recommendations for action plans in eight areas.

Initiative to Define Weather Requirements for Safety, Capacity, and Operational Efficiency

We are now entering the second phase of this comprehensive effort to define detailed weather information needs for pilots, dispatchers, and air traffic controllers. This initiative is taking advantage of extensive user participation to help define the required access to weather information and to address the best format for disseminating the information, e.g., graphic versus alphanumeric.

FAA/NWS Memorandum of Understanding

A Memorandum of Understanding between the FAA and the NWS is in the final review process within the FAA. This formal document will spell out the overall division of responsibilities in providing weather service to air traffic controllers and industry users. It will help to reduce the confusion among users about which agency is responsible for various aviation weather services.

PLANS FOR THE FUTURE

AIRPORT TACTICAL INITIATIVES

The recommendations by Airport Capacity Design Teams have emphasized constructing new runways and taxiways, installing enhanced facilities and equipment, and changing instrument approach procedures. These improvements are normally processed through established, long-term procedures. The Capacity Office has recently initiated an effort to identify, evaluate, and implement capacity improvements that are achievable in the near term and will provide more immediate relief for chronic delay-problem airports.

Airport Capacity Enhancement (ACE) Action Teams, made up of representatives from airport operators, air carriers, other airport users, and aviation industry groups together with FAA representatives, are now being established at selected airports to assess near-term, tactical initiatives and guide them through implementation.

The first of these ACE Action Teams has been established at Los Angeles International Airport. The team is evaluating the impact on the crossfield taxiway system of proposed new gates on the west side of the Tom Bradley International Terminal immediately adjacent to

the taxiway system. The study will examine the causes of delay associated with operations in the terminal area and evaluate capacity benefits and delay-cost savings of proposed improvements.

TERMINAL AIRSPACE STUDIES

When an Airport Capacity Design Team study is completed, an airport has a recommended plan of action to increase its capacity. But, this plan will do little good if the airspace in the vicinity of the airport cannot handle the increased traffic. For this reason, the Capacity Office has been developing a program of Airspace Capacity Design Team studies of the terminal and en route airspace associated with delay-problem airports across the country. These studies are intended to follow the Airport Capacity Design Team studies. The first of these Terminal Airspace Studies are currently being planned for Philadelphia International Airport and Seattle-Tacoma International Airport.

REGIONAL CAPACITY DESIGN TEAMS

Looking beyond the individual airport and its immediate airspace, the Capacity Office is planning a series of Regional Capacity Design Team studies. These regional studies will analyze all of the major airports in a metropolitan or regional system and model them in the same terminal airspace environment. This regional perspective will show how capacity-producing improvements at one airport will affect air traffic operations at the other airports and within the terminal airspace. The first of these regional studies is planned for the Los Angeles Basin airports.



Los Angeles International Airport looking west toward the Tom Bradley International Terminal.

AIRSPACE DEVELOPMENT

The Airspace Capacity Design Program will continue to undertake projects to study capacity and delay problems and support planning efforts related to air traffic operations. The goal is to identify, test, and quantify capacity-enhancing modifications to the national airspace structure to ensure that airspace constraints are not a limiting factor on the air transportation system.

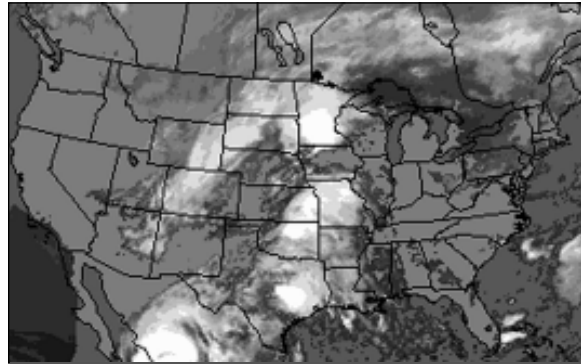
IMPROVED INSTRUMENT APPROACH PROCEDURES

New air traffic control approach procedures continue to be developed to take advantage of improving technology, enhance system capacity, and improve flight safety. The goal is to have capacity during IMC equal capacity during VMC. The Capacity Office will work closely with Air Traffic, Flight Standards, Aviation Standards, Research and Development, and the FAA Technical Center to ensure these new procedures are thoroughly tested, to include real-time simulations and live demonstrations.

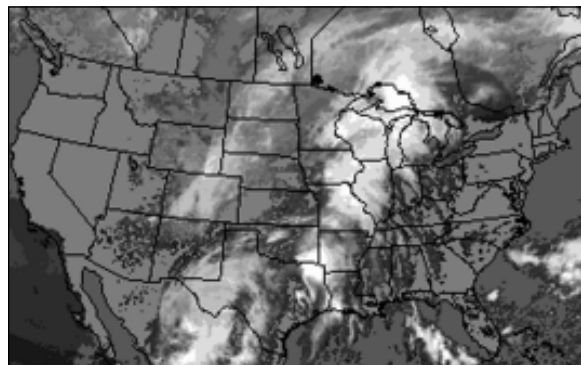
AVIATION WEATHER

The Capacity Office will continue as an integral part of the FAA's overall effort to improve aviation weather service. Work has begun on developing the action plans recommended by the National Aviation Weather Program Plan (NAWPP), and work is continuing on implementation of international aviation weather codes for surface observations (METAR) and terminal forecasts (TAF).

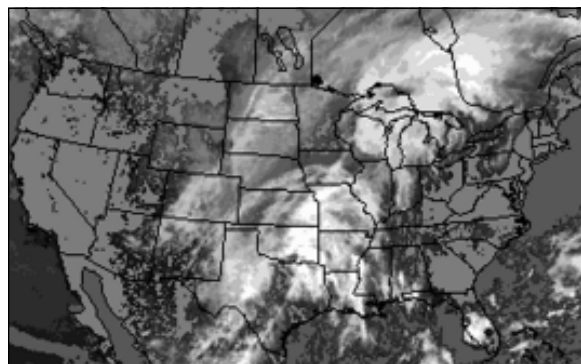
As a part of this effort, the Capacity Office will be hosting a National Aviation Weather Users Forum, currently scheduled for November 30 through December 2, 1993, in the Washington, D.C. area. This public meeting, to which aviation weather users and providers are invited, is intended to get industry validation of detailed user needs and priorities and to define responsibilities for aviation weather services in terms of who provides, who pays, who sets standards, and which services are regulated.



U.S. Weather Satellite Photo, 09/13/93, 0500 EDT.



U.S. Weather Satellite Photo, 09/13/93, 1300 EDT.



U.S. Weather Satellite Photo, 09/13/93, 1800 EDT.

MISCELLANEOUS

CAPACITY INITIATIVES PAMPHLET

The second in a series of pamphlets on *Capacity Initiatives* is being prepared now for publication. The latest pamphlet will describe capacity-producing improvements in air traffic control procedures, increased utilization of multiple runways, and new radar systems and other technologies that have recently become available or will be available in the next three to five years. It should be published during the Fall of 1993. The first pamphlet in the series, entitled *Near-Term Capacity Initiatives*, was published in July 1992 and reprinted in September 1992.

AVIATION SYSTEM CAPACITY PLAN

The *1993 Aviation System Capacity Plan* should be published and available for distribution by the Fall of 1993. Copies of the plan will be sent to the same distribution list as the previous year's plan. Please send any requests to be included on the distribution list to the Office of System Capacity and Requirements.

QUESTIONS, COMMENTS, REQUESTS

Any questions or comments concerning our *Annual Report* or any of our efforts in the Capacity Office would be greatly appreciated. These and any requests for publications should be directed to:

Federal Aviation Administration
Office of System Capacity and Requirements
800 Independence Avenue, S.W.
Washington, D.C. 20591
(202) 267-7370

FOOTNOTES

- 1 *FAA Aviation Forecasts, Fiscal Years 1993–2004*, FAA – APO 93–1, February 1993. The economic scenario used to develop the FAA Aviation Forecasts for the period 1993 through 1998 was provided by the Executive Office of the President, Office of Management and Budget (OMB). For the period from 1999 through 2004, the economic scenario used consensus growth rates of the economic variables, based on forecasts prepared by DRI/Mc Graw-Hill, Evans Econometrics, and the WEFA Group.
 - 2 Aircraft direct operating costs include fuel, crew, aircraft maintenance, and the like, but not the costs of passenger inconvenience or time lost. Actual average aircraft operating costs depend on the mix of aircraft types operating at each individual airport.
 - 3 The average aircraft direct operating cost for the mix of aircraft types operating at Charlotte/Douglas International Airport was \$1,400 per hour in 1989 dollars. This value was used to compute delay-cost savings at all demand levels.
 - 4 The average aircraft direct operating costs for the mix of aircraft types operating at Detroit Metropolitan Wayne County Airport were \$1,550 per hour at 409,000 aircraft operations per year and \$1,649 per hour at 500,000 operations per year (in 1989 dollars).
 - 5 The average aircraft direct operating cost for the mix of aircraft types operating at Phoenix Sky Harbor International Airport was \$1,080 per hour in 1988 dollars. This value was used to compute delay-cost savings at all demand levels.
 - 6 The average aircraft direct operating cost for the mix of aircraft types operating at Nashville International Airport was \$986 per hour in 1989 dollars. This value was used to compute delay-cost savings at all demand levels.
 - 7 The average aircraft direct operating cost for the mix of aircraft types operating at Orlando International Airport was \$1,657 per hour. This value was used to compute delay-cost savings at all demand levels.
 - 8 The city of Austin now plans to convert Bergstrom Air Force Base, which will be transferred to the city in 1993, into the new Austin airport and relocate all commercial activity there in 1997–1998.
- † Based on the average direct operating costs of \$1,600 per hour. See page 5.

